

What is claimed is:

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- 1 1. An apparatus comprising:  
2 a transparent plate with an upper surface; and  
3 a plurality of spaced apart fiducials formed on the upper surface at locations  
4 corresponding to desired die locations.
  - 1 2. The apparatus of claim 1, wherein the transparent plate is glass.
  - 1 3. The apparatus of claim 2, wherein the glass is quartz.
  - 1 4. The apparatus of claim 1, wherein the fiducials are formed by electron-beam  
2 lithography.
  - 1 5. The apparatus of claim 1, wherein the spaced apart fiducials have a  
2 placement accuracy equal to or less than 2 microns, 3 sigma.
  - 1 6. An apparatus comprising:  
2 a transparent plate having fiducials on a surface, the transparent plate  
3 adapted to be positioned beneath a panel having transparent segments so that a die  
4 suspended above the panel and having a die alignment mark can be aligned and  
5 positioned relative to at least one of the fiducials.
  - 1 7. The apparatus of claim 6, wherein the transparent plate is made of glass.
  - 1 8. The apparatus of claim 7, wherein the glass is quartz.
  - 1 9. The apparatus of claim 6, wherein the fiducials are chrome.

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1 10. An apparatus comprising:  
 2 a movable pick-up head capable of holding, positioning and releasing a die,  
 3 the die having an alignment mark;  
 4 a panel support member adapted to movably support a panel in a panel  
 5 support plane, the panel having upper and lower surfaces and an array of cavities  
 6 each open at the upper surface and each having a transparent bottom;  
 7 a transparent plate with fiducials arranged at locations corresponding to  
 8 desired die locations, the transparent plate arranged adjacent the panel support plane  
 9 opposite the movable pick-up head; and  
 10 an optical vision system adapted to image at least one fiducial and generate  
 11 an electrical signal corresponding to the position of the at least one fiducial.

1 11. The apparatus of claim 10, further including a controller electrically  
 2 connected to the pick-up head and the optical vision system, the controller adapted  
 3 to control the movement of the pick-up head in response to the electrical signal.

1 12. The apparatus of claim 10, wherein the transparent plate is made of glass.

1 13. The apparatus of claim 11, wherein the glass is quartz.

1 14. The apparatus of claim 10, wherein the fiducials are formed by electron-  
 2 beam lithography.

1 15. A method comprising:  
 2 providing a panel with a plurality of cavities, each cavity including an  
 3 opening to a panel upper surface and a transparent bottom at a panel lower surface;  
 4 arranging adjacent the panel lower surface a transparent plate having an  
 5 upper surface with a plurality of fiducials formed thereon, with one fiducial aligned  
 6 with the each cavity transparent bottom and serving as a local fiducial; and  
 7 imaging the local fiducial to align the die to the cavity.

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- 1 16. The method of claim 15, further including determining a position of the die  
2 relative to the local fiducial based on said imaging.
- 1 17. The method of claim 16, including generating an electrical signal  
2 corresponding to the die position relative to the local fiducial.
- 1 18. The method of claim 17, further including aligning the die with the local  
2 fiducial.
- 1 19. The method of claim 18, further including:  
2 inserting the die into the opening of the cavity associated with the local  
3 fiducial; and  
4 contacting the die to the transparent bottom.
- 1 20. The method of claim 15, including forming the fiducials using electron-  
2 beam lithography.
- 1 21. A method comprising:  
2 forming fiducials on an upper surface of a transparent plate;  
3 arranging the transparent plate relative to a panel having multiple cavities  
4 formed in a panel upper surface, with each cavity having a transparent bottom, said  
5 arranging including aligning each fiducial beneath a corresponding one of the  
6 multiple cavities; and  
7 imaging a select one of the fiducials corresponding to a select one of the  
8 cavities to establish a die position relative to the select one of the cavities.
- 1 22. The method of claim 21, including making the transparent bottom adhesive.
- 1 23. The method of claim 21, including aligning the die alignment mark to the  
2 select fiducial.

1 23. The method of claim 23, further including placing the die onto the  
2 transparent bottom of the select cavity.

1 24. The method of claim 21, including imaging the die alignment mark  
2 through the transparent bottom.

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